Three Valleys Water - Capital Alliance Programme

a £2.2M Sludge Treatment System Upgrade

by
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The WTW is situated in the north Surrey region and supplies potable water to approximately a quarter of a million people. It abstracts and treats river water from the Thames to meet this demand. Historically, especially during periods of high river water turbidity - predominantly caused by heavy rainfall and seasonal algal blooms - the sludge treatment and sludge handling facility at the works has been unable to fully deal with the increased solids loading. Investigation and outline design led to a series of Process, M&E and ICA engineering improvements and upgrades being implemented through the Three Valleys Water AMP4 Capital Alliance Programme.

New Thickened Sludge Transfer Pump skid. Existing WRc Thickener in background *Courtesy of Three Valleys Water*

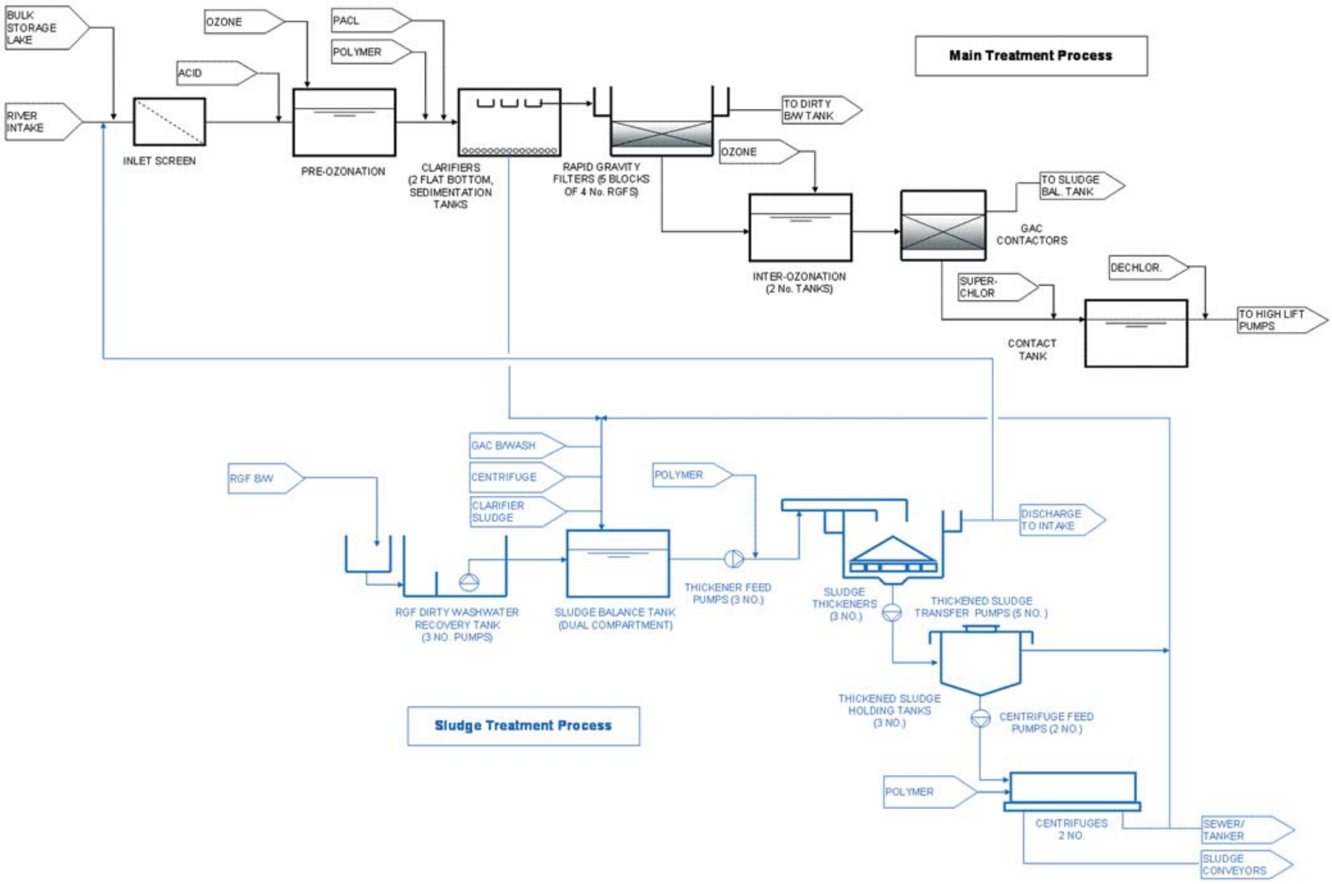
Introduction
The water treatment process at the treatment works comprises pre-ozonation, clarification, rapid gravity filtration (RGF), inter-ozonation, granular activated carbon (GAC) and super-chlorination and de-chlorination stages before being pumped into the supply zone.

The sludge treatment and processing plant, which was installed in the early 1990s, handles the by-products of this process. A dirty wash water tank collects RGF backwash water and rainwater, and a sludge balance tank collects the washings from the GAC contactors and centrifuge centrate.

The sludge process stream had a number of operational restrictions which were the root cause of the treatment works having to limit its output when difficulties were being experienced. A lack of fully-automated equipment also added to the inefficiency of plant as a whole. The main project drivers were the elimination of these constraints to optimise works production and an increased security of supply to the supply zone.

Design and Procurement
The whole of the project works was competitively tendered with MWH Constructors being the successful appointee in October 2007 with a Completion date of March 2009. The contractor was appointed under NEC3: Option A (Priced Contract with Activity Schedule) for £1.7m. A major addendum to the project scope was requested by Three Valleys Water through a Statement Of Need (SON) in which it was requested that eleven sedimentation tanks were refurbished.

In order to produce a detailed Invitation To Tender (ITT) Mace Group's engineering department produced a 30% design accompanied by detailed specifications. The contract was then appointed as a 'design and construct' allowing smaller risk sums to be required on both sides of the contract party.



Process Flow Diagram *Courtesy of Three Valleys Water*

Process Issues and Improvements

RGF Dirty Wash water Pumps

The dirty wash water tank is an open concrete cell and collects RGF backwashes and rainwater from the RGF and clarifier building roofs. The predominant issue with this asset was the infiltration of media from the backwashing phase of the RGF process, which was being transferred through the sludge system. The installation of a 1m high weir wall in the sump served to prohibit media particles from entering the pumps. The dirty wash water pumps and downstream pipe were replaced and sized to allow capacity for predicted investment needs identified for AMP5.

Sludge Balancing Tank

The dirty wash water pumps feed a two-compartment, below-ground sludge balance tank that does not have a full height dividing wall. This tank also collects sludge from the clarifiers, GAC backwash, sludge storage tank overflow and centrifuge centrate. Minimal electrical changes were identified for this asset for incorporation in the new MCC.

Thickener Feed Pumps

There are three thickener feed pumps transferring sludge from the sludge balancing tanks to the WRc thickeners. Historically, the sludge balancing tank had a tendency to overflow when downstream processes provided constraints. The three thickener feed pumps were running continuously with no standby arrangement. The project provided a system that, through replacement of the pumps with variable delivery rates and a stand-by function, allowed Operations to control the balance tank level with consistent operation of the thickeners.

Sludge Thickeners

There are three WRc circular sludge thickeners at the treatment works, two of which were installed with the original plant and a third was added later. The general performance of all three thickeners was sub-optimal, largely due to unreliable desludging controls. These thickeners routinely produced a thin sludge that fell short of the 5% dry solids operational target. In addition, the inlet launder to the third thickener was also suspected to be causing floc break-up upon entering the vessel. To eradicate these problems, a new and more sophisticated sludge level detection and sludge concentration system was installed in each thickener. The inlet launder channel on the third thickener was modified to mirror the other thickeners to prevent the destruction of flocs.

Thickened Sludge Transfer Pumps

Thickened sludge was previously withdrawn from each thickener by a progressive cavity transfer pump with a fourth pump provided as a common standby. Under the project five new pumps were installed and the location moved to ground level to improve operational and maintenance access. Historically, sludge thickeners No.1 and No.2 each had a dedicated thickened sludge transfer pump and shared a standby pump arrangement. Sludge thickener No.3 has its own duty and standby thickened sludge transfer pumps. The new pump skid arrangement has been designed to provide better duty and standby facilities for the transfer of thickened sludge.

Thickened Sludge Storage Tanks

The three thickened sludge storage vessels are open-topped cylindrical tanks with hopper bottoms. The tanks had no facility for mixing, or supernatant recycle, and were open to the atmosphere, allowing debris to infiltrate the system and block the outlet screens. The absence of mixers in the storage tanks led to stratification and, consequently, the feed to the centrifuges was inconsistent. The project provided for the tanks to be covered and installed a pumped recirculation system to keep the tanks' sludge well mixed.

Sludge Discharge Conveyors

The existing arrangement comprised two horizontal screw conveyors, rated at 2.0 tonne/hr, designed for removing centrifuge cake from the outlet of each centrifuge. These conveyors discharged outside the building into a common collection hopper inlet and then into a single inclined screw conveyor which filled two RoRo-type skips.

The system was identified as a single point of failure and to eliminate this, a new conveyor system was installed to provide each centrifuge with a dedicated 2.5tonne/hr cake conveyor and skip loading system. The skip filling system is now fully automated and consequently operator attendance is only required during the removal of full skips and the cake is consistently in the range of 20 - 22% dry solids.

Polyelectrolyte Storage, Preparation and Dosing

The existing polymer system, from the study phase, was deemed to be in poor condition and at the end of its useful life. Retro-fitted equipment over the years made it a cumbersome and difficult to access system. The polymer powder storage, solution preparation and dosing plant originally comprised streams with one dosing to the centrifuges and the other to the sludge thickeners. Polymer powder was manually-handled using bags to fill feed hoppers. Blower units then conveyed the powder to the preparation tanks. The same polymer could be used for both applications, therefore, new polymer storage and make-up systems were installed in duty and standby arrangement. Replacement dosing pumps to the centrifuges (three) and the thickeners (four) were also installed. A brand new, properly designed asset allowed the centrifuges and thickeners to run in a more controlled and optimised fashion.

Conclusions

This project has been a challenge for the project team. A key component of the delivery was that existing plant must be kept running or available at all times. Interfaces with existing, ageing kit has proved to be a challenge that has been professionally dealt with by TVW Operations and the contractor and, with correct provision made within the contract risk allocations, has not proved to be a funding issue. At the time of writing, the project is going through final Site Acceptance testing.

The project team comprised Three Valleys Water (client), Mace Group Utilities (project/programme management), MWH Constructors (principal contractor), MWH UK (designer), WES and CIBA (process), B-Meck, DD-Engineering and Spirac (mechanical), Econotech (electrical), Towey Construction (civils works); Riverside (software).

Note: ***Guy Walker is a Senior Project Manager for Mace Group (Utilities) delivering partnering Above Ground Asset projects for Three Valleys Water's AMP4 Capital Alliance Programme. The author wishes to express thanks to Melanie Cussins - Mace Group Process Engineer - in assisting with the preparation of this paper.*** ■

Horizontal Screw Conveyors feeding external hoppers for the inclined Conveyor system *Courtesy of Three Valleys Water*